HEAD SUSPENSION WITH VIBRATION DAMPING FOR A DATA STORAGE DEVICE

Field of the Invention

The invention relates to the field of data storage devices. More particularly, but not by way of limitation, this invention relates to a combination and method for dissipating excitation experienced by components in a data storage device.

Background

One key component of any computer system is a device to store data. One common type of data storage device is a disc drive. The most basic parts of a disc drive are an information storage disc that is rotated, an actuator that moves a read/write head (head) to various locations over the substantially concentric data tracks of a disc, and electrical circuitry used for encoding data so that the data can be successfully retrieved and written to the disc surface. A microprocessor controls most of the operations of the disc drive including passing requested data read by the transducer to the computer system and receiving data from the computer system for storage on the disc.

A problem associated with disc drives is vibrations at certain frequencies, which causes the head to move off a designated data track. In other words, if there is even a slight vibration, the head may move away from the center of the designated data track, causing data to be misread or causing a failure to properly write data. One source of vibration results from a seek operation that excites head suspensions, which in turn causes the head to vibrate. The vibration causes run-out, i.e., an off-track motion, and off-track motion becomes more acute as the density of the data tracks increase. As such, challenges remain and a need persists for improvements in methods and apparatus to reduce vibrations in head suspensions for data storage devices.

Summary of the Invention

In accordance with preferred embodiments, a method, apparatus and combination are provided for dissipation of vibrations experienced by a read/write head of a data storage device. The combination includes a rotating disc in a data exchange relationship with a read/write head, which is supported by a head suspension formed by steps for forming the head suspension.

In one aspect, the method includes forming a mounting region of the head suspension adjacent a bend region, forming a load beam region adjacent the bend region, and removing material from the bend region to form a strut and a damping material support structure. The method preferably continues with the steps of severing the strut from the damping material support structure to provide an isolation aperture and a base portion of the damping material support structure. A damping material is preferably affixed to the strut and the damping material support structure, wherein the damping material partially obstructs the isolation aperture.

In another aspect, an apparatus comprising a head suspension that preferably includes a mounting region that has a mounting aperture with an attachment member secured adjacent the mounting aperture, and a bend region with an aperture bounded by a number of struts. The struts regulate an amount of spring force imparted to a read/write head. The apparatus further preferably includes a load beam region with a damping material support structure adjacent a bend member, the damping material support structure is offset from the struts and extends into the aperture.

Preferably, the load beam region includes a proximal end adjacent the bend region and a distal end with a rigid portion. The distal end extends from the proximal end and a flexure is preferably affixed to the rigid portion to support the read/write head. Preferably, the damping material support structure extends into the aperture from the proximal end of the load beam to allow an adhesion of the damping material to the struts while minimizing potential exposure of the read/write head and the disc to an adhesive medium of the damping material.

These and various other features and advantages that characterize the claimed invention will be apparent upon reading the following detailed description and upon review of the associated drawings.

Brief Description of the Drawings

FIG. 1 is a partial cutaway top plan view of a data storage device (DSD) that incorporates a head suspension of the present invention.

FIG. 2 is a top plan view of the head suspension of **FIG. 1**.

FIG. 3 is a top perspective view of the head suspension of **FIG. 2**.

FIG. 4 is a flow chart of a method of forming the head suspension of **FIG. 2**.

Detailed Description

Referring now to the drawings, **FIG. 1** provides a top plan view of a data storage device (DSD) **100**. The DSD **100** includes a base deck **102** cooperating with a top cover **104** (shown in partial cutaway) to form a sealed housing for a mechanical portion of the DSD **100**, referred to as a head-disc assembly **106**.

A spindle motor assembly **108** rotates a number of data storage discs **110** with a magnetic recording surface **111** at a substantially constant operational speed. An actuator assembly (actuator) **112** supports and rotates a number of read/write heads (heads) **114** adjacent the magnetic recording surfaces **111** when current is applied to a coil **116** of a voice coil motor (VCM) **118**. A head suspension **120** provides a predetermined spring force on the head **114** to maintain a proper data exchange relationship between the head **114** and the disc **110** during operation of the DSD **100**. Additionally, the head suspension **120** serves to connect the head **114** with an actuator arm **122** of the actuator **112**.

During operation of the DSD **100**, the actuator **112** moves the heads **114** into a data exchange relationship with the disc **110**, i.e., the actuator **112** moves the heads to data tracks **124** on the surfaces **111** to write data to and read data from the discs **110**. When the DSD **100** is deactivated, the actuator **112** positions the heads **114** adjacent a home position **126** and the actuator **112** is confined by latching a toggle latch **128**.

Command, control and interface electronics for the DSD **100** are provided on a printed circuit board assembly **130** mounted to the head-disc assembly **106**. During data transfer operations, a preamplifier/driver (preamp) **132** attached to a

flex circuit **134** conditions read/write signals conducted by the flex circuit **134** between the printed circuit board assembly **130** and the heads **114**.

FIG. 2 shows a preferred embodiment of the head suspension **120**, which includes a damping material support structure **136**. The damping material support structure **136** allows a large damping material **138** to be applied in a high strain area **140**, without undue exposure of an adhesive (not shown) of the damping material **138** or damage to a bend region **142** of the head suspension **120**. The large damping material **138**, enabled by the damping material support structure **136**, helps to dissipate undesirable resonant vibrations in the head suspension **120**.

In a preferred embodiment, the bend region **142** has a pair of bend members (also referred to herein as struts) **144** used to achieve a desired spring rate and load for the head **114**. As a result, the strain energy for most resonant modes is highest in the high strain area **140** of the struts **144**. Dampers are most effective in areas of high strain and the damping material support structure **136** promotes a cost effective application of damping to the struts **144**. Because of the preferred embodiment configuration of the damping material support structure **136**, ease in manufacturing of the damping material **136** results, due to its relatively large surface area. The relatively large surface area of the damping material **136** further provides the benefit of enhancing an accurate placement and application of the damping material **136** to the bend region **142** during the assembly process of the DSD **100** (of FIG.1).

An adhesive medium is preferably used to affix the damping material **138** to the struts **144** and to the damping material support structure **136**. Excessive adhesive exposure may cause difficulties with handling the actuator **112** (of **FIG. 1**), and may further outgas particles into the head-disc assembly **106** (of **FIG. 1**), which can damage the disc **110** (of **FIG. 1**) or the head **114**. The damping material support structure **136** minimizes adhesive exposure, without affecting performance of the struts **144**. Preferably, adhesive exposure is minimized because the damping material support structure **136** supports the large damping material **138** and substantially covers the exposed adhesive area of the large damping material **138**.

FIG. 2 also shows a preferred isolation aperture **146**, i.e., a thin space between the damping material support structure **136** and the struts **144** to maintain

suspension performance, but still provide access to the high strain area **140** on the struts **144** for application of the damping material **138**.

FIG. 3 shows a mounting region **148** adjacent the bend region **142**. **FIG. 3** also shows a load beam region **150** with a proximal end **152** adjacent the bend region **142**. The load beam region **150** preferably includes a rigid portion **154** on a distal end **156** and a preferential stiffening rail **158** (two shown) commencing at the proximal end **152** and extending to the distal end **156**. The rigid portion **154** supports a flexure **160** upon which the head **114** (of **FIG. 1**) is preferably mounted. The stiffening rail **158** facilitates conveyance to the head **114** of a load developed by the spring rate of the strut **144**.

FIG. 3 also shows a base portion **162** of the damping material support structure **136** preferentially adjacent the proximal end **152** of the load beam region **150**. The damping material support structure **136** preferably extends from the base portion **162** into an aperture **164**. During formation of the aperture **164**, a mounting aperture **166** is preferentially formed in the mounting region **148**, and an attachment member **168** is preferably affixed adjacent the mounting aperture **166**. The attachment member **168** facilitates mounting of the head suspension **120** to the actuator arm **122** of the actuator **112** (of **FIG. 1**).

Preferably, the amount of material removed during formation of the aperture **164** substantially determines the dimensions of the strut **144**. The dimensions of the strut **144** determines the amount of spring force and load applied to the head **114** (of **FIG. 1**) to assure the proper fly height of the head **114** during operations of the DSD **100** (of **FIG. 1**). **FIG. 3** further shows, an optional mass adjustment area **170** that may be etched onto the load beam region **150** to decrease the overall mass of the load beam region **150**.

FIG. 4 shows a head suspension formation process **200** beginning at start step **202** and continuing at process step **204**. Preferably, at process step **204**, a mounting region (such as **148**), a bend region (such as **142**) and a load beam region (such as **150**) are formed. At process step **206**, material is removed to preferentially form a strut (such as **144**), a damping material support structure (such as **136**) and an aperture (such as **164**). The amount of material removed during formation of the aperture substantially defines the dimensions of the strut **144**, which determines the amount of spring force and load applied to a head (such

as **114**) of a DSD (such as **100**).

At process step **208**, a mounting aperture (such as **166**) and an isolation aperture (such as **146**) are provided by removing material from the mounting region (for the mounting aperture), and from the bend region (for the isolation aperture). The isolation aperture preferably provides a separation between the damping material support structure and the strut to assure non-interference with the operation of the strut by the damping material support structure. An attachment member (such as **168**) preferably encloses the mounting aperture and provides a means for mounting the head suspension to an actuator arm (such as **122**) of an actuator (such as **112**) of the DSD.

At process step **210**, a stiffening rail (such as **158**) and a rigid portion (such as **154**) are preferably formed in the load beam region. The stiffening rail transfers the load developed by the spring force from the strut to the head, and the rigid region supports a flexure (such as **160**) used to attach the head. At process step **212**, an optional mass adjustment area (such as **170**) is etched into the load beam region to reduce the overall mass of the load beam region. At process step **214**, the attachment member is joined to the mounting region and the flexure is joined to the rigid portion of the load beam region.

At process step **216**, the damping material is attached to the strut and the damping material support structure. Preferably, the damping material exhibits a damping coefficient higher than the damping coefficient of the material adjacent the isolation aperture. Also preferably, the damping material is constructed from layered dissimilar materials. For example, elastomeric materials have been found useful as part of the dissimilar materials used to form the damping materials. The head suspension formation process **200** concludes at end process step **218**.

Accordingly, embodiments of the present invention are generally directed to a method (such as **200**, as described hereinabove), an apparatus (such as **120**), and a combination (such as **100**) which includes a rotating disc (such as **110**) in a data exchange relationship with a read/write head (such as **114**) supported by a head suspension (such as **120**) apparatus as formed by the method.

The method preferably includes the steps of; forming a mounting region (such as **148**) adjacent a bend region (such as **142**) while a load beam region (such as **150**) is formed adjacent the bend region (such as by process step **204**); removing

material (such as by process steps **206** and **208**) from the bend region forms an aperture (such as **164**), a strut (such as **144**), an isolation aperture (such as **146**) and a damping material support structure (such as **136**). The method preferably continues with the step of affixing a damping material to the strut and the damping material support structure (such as by process step **216**).

The apparatus includes the bend region preferably adjacent both the mounting region and the load beam region. The load beam region includes a rigid portion (such as **154**), which preferably supports a flexure (such as **160**). The flexure provides means for attaching the read/write head to the head suspension. The apparatus further preferably includes the damping material attached to both the strut and the damping material support structure.

It will be clear that the present invention is well adapted to attain the ends and advantages mentioned as well as those inherent therein. While presently preferred embodiments have been described for purposes of this disclosure, numerous changes may be made which will readily suggest themselves to those skilled in the art and which are encompassed in the appended claims.